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Research on the Installation Process of T-shaped High-Precision Embedded Parts

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Abstract: *This study focuses on the high-precision installation requirements of equipment foundation embedded parts in nuclear power engineering and proposes an innovative installation process for T-shaped high-precision embedded parts. Through detailed construction procedures and technical requirements, including measurement and line setting, hole reservation and cleaning, positioning and installation, and fine-aggregate concrete pouring, the stability and accuracy of the embedded parts during installation are ensured. Practical results show that this process significantly improves the installation quality of embedded parts, meeting the high requirements for equipment stability and safety in nuclear power engineering and providing valuable technical references and experience for similar projects.*

Keywords: *T-shaped High-Precision Embedded Parts; Nuclear Power Engineering; Installation Process; Stability; Precision Control*

1. Introduction

In the complex and precise field of nuclear power engineering, the stability and safety of internal equipment are crucial. The installation precision of equipment foundation embedded parts, as key components to ensure stable equipment installation, directly affects the efficiency and safety of the entire nuclear power project [1]. Especially for core facilities like electrical panels, DCS equipment, and battery storage devices, the installation precision requirements for their embedded parts are almost stringent [2]. These embedded parts must not only bear the weight and dynamic loads of the equipment but also meet very high requirements for levelness, elevation, and axial position accuracy to ensure smooth equipment operation and precise interfacing [3].

However, traditional installation methods for embedded parts are often inadequate in meeting these high-precision requirements [4]. Ordinary embedded parts, due to their thin walls and limited length, struggle to meet the demands of high-precision installation [5]. Moreover, the lack of effective on-site adjustment methods in traditional installation processes makes it difficult to correct deviations in embedded part installation in a timely and effective manner [6-7].

In response to this challenge, this study, after in-depth theoretical analysis and repeated on-site practice, has proposed an innovative installation process for T-shaped high-precision embedded parts. This process, through a series of detailed operations including block fabrication, reserved secondary post-pour zones, block hoisting, and on-site assembly, not only effectively enhances the rigidity and stability of the embedded parts but also provides greater flexibility and adjustability during the installation process. Through on-site measurements and adjustments of the embedded parts' elevation and levelness, followed by precise welding and pouring, this study successfully achieves effective control over the installation precision of T-shaped high-precision embedded parts.

Practical results show that the installation process for T-shaped high-precision embedded parts proposed in this paper not only ensures that all installation indicators of the embedded parts meet the design requirements but also significantly improves construction efficiency and quality. This achievement brings significant economic and social benefits to the field of nuclear power engineering construction and provides valuable experience and technical references for similar high-precision

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embedded part installation projects.

2. Process Characteristics

The installation process of T-shaped high-precision embedded parts is primarily characterized by its pursuit of utmost precision in construction. In contrast to traditional embedding methods, this technique significantly enhances controllability and accuracy through a combination of segmented fabrication and on-site assembly. The segmented approach not only mitigates installation complexities arising from excessive material lengths but also effectively prevents deformation during installation through precise calculation and design of segmentation points, thus ensuring that each embedded part meets the stringent precision requirements.

Furthermore, this process emphasizes meticulous preparatory work, particularly the pre-reservation of a secondary post-pouring area before concrete casting. This measure not only provides room for adjustments during installation but also ensures a tight bond between the embedded parts and the concrete, thereby enhancing the overall stability of the installation.

For multiple T-shaped high-precision embedded parts located within the same area, the process employs a synchronized concrete casting method. Through coordinated casting operations, it ensures precise relative positioning between adjacent embedded parts, fulfilling the demands of complex installation designs.

3. Process Principles

The principles underlying the installation process of T-shaped high-precision embedded parts are founded on the integrated application of precise measurement, segmented fabrication, precise adjustment, and robust fixation. Initially, high-precision measuring instruments and advanced setting-out techniques are utilized to accurately determine the theoretical position and elevation of each embedded part, providing a solid foundation for subsequent fabrication and installation work.

During the segmented fabrication stage, scientific segmentation strategies and precise machining techniques are employed to ensure that each segment meets design requirements and can be seamlessly integrated during on-site assembly. The practice of reserving a secondary post-pouring area not only facilitates fine adjustments during installation but also effectively mitigates the impact of potential stresses on the precision of the embedded parts during concrete casting.

During the on-site assembly phase, real-time measurement and meticulous adjustment are carried out to ensure that the elevation and flatness of each embedded part meet the design requirements. Simultaneously, specialized fixing devices and welding techniques are employed to secure a robust connection between the embedded parts and the concrete structure.

Finally, during the concrete casting and curing process, strict construction control and monitoring are implemented to ensure complete integration between the embedded parts and the concrete, further enhancing the stability and durability of the entire installation system.

In summary, the characteristics and principles of the T-shaped high-precision embedded part installation process reflect the stringent requirements for precision and stability in modern engineering construction. Through the integrated application of professional techniques such as precise measurement, segmented fabrication, precise adjustment, and robust fixation, the process ensures the high-quality completion of embedded part installations, providing reliable technical support for fields with stringent precision requirements such as nuclear power engineering.

4. Construction Process and Technical Requirements

To ensure the stability and precision of T-shaped high-precision embedded parts during installation, this study carefully planned and implemented a series of detailed construction methods. First, for embedded parts longer than 6 meters, a block fabrication strategy is adopted. By accurately calculating and reasonably designing the segmentation points, both the structural stability of the embedded parts and the avoidance of deformation problems due to excessive length during installation are ensured, thus achieving the preset precision standards for embedded part installation.

Second, when the floor design requires the placement of T-shaped high-precision embedded parts,

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special emphasis is placed on the preparatory work before concrete pouring, especially reserving a secondary post-pour zone before pouring, leaving space for subsequent adjustments and optimizations, further enhancing the guarantee of precision and stability in embedded part installation.

Furthermore, for T-shaped high-precision embedded parts located in the same room, a method of synchronous concrete pouring is adopted. Through unified and coordinated pouring operations, the relative position accuracy of adjacent two or three or more groups of embedded parts is ensured, strictly meeting the precision requirements of the installation design.

In the specific construction process, a series of detailed operations including block fabrication, reserving secondary post-pour zones, block hoisting, and on-site assembly are carried out. Especially in the on-site assembly stage, real-time measurements and adjustments are made to the elevation and levelness of the embedded parts, ensuring the precision of each installation step. Subsequently, on-site assembly welding is performed, and continuous remeasurement of the embedded parts is conducted during the pouring process, ensuring the accuracy and controllability of the entire installation process.

4.1. Process Flow

The overall process flow includes: embedded part measurement and line setting → embedded part hole reservation → positioning line setting and hole cleaning → high-precision embedded part installation → fine-aggregate concrete pouring → curing.

4.2. Embedded Part Measurement and Line Setting

T-shaped high-precision embedded parts are usually installed on the top of the floor slab, and their measurement and line setting work should be carried out after the completion of the floor slab rebar tying. To avoid conflicts between the anchor bars of high-precision embedded parts and floor slab rebars, the positions of the anchor bars should be measured and avoided in advance on the formwork to ensure the smooth installation of high-precision embedded parts. Before installation, it is necessary to measure and set out the axial positioning lines and the elevation control lines of the embedded parts to ensure their precise positioning and leveling during installation.

4.3. Embedded Part Hole Reservation

The method for reserving holes for embedded parts mainly uses filling with extruded polystyrene boards or wire mesh templates Wire mesh templates are suitable for areas with sparse rebar, while extruded boards are commonly used in areas where wire mesh cannot be installed or where rebar is dense. To ensure the concrete elevation of the floor slab at the location of the embedded parts meets requirements, the extruded board templates need to be reinforced to prevent floating. The reinforcement method can include welding short rebars to the floor slab rebar. For wire mesh templates, short rebars and wood blocks should be used as backing support frames. In addition, the exterior of the wire mesh should be wrapped with a thin plastic film to prevent concrete leakage (see Figure 1).

a) Extruded Board Schematic *b) Wire Mesh Template Schematic*

Figure 1: Schematic of the Method for Reserving Holes for Embedded Parts

4.4. Positioning Line Setting and Hole Cleaning

Before the installation of high-precision embedded parts, it is necessary to measure and set out the positioning lines of the T-shaped high-precision embedded parts in advance. After the floor slab concrete pouring, check for deviations, displacements, and other issues in the reserved hole edges and center lines based on the positioning lines. If deviations are found, the concrete should be chiseled to the reserved hole position as per design requirements. For reserved hole positions supported by wire mesh templates, chiseling should be carried out only after the first concrete pouring and curing period has ended. The sides and bottom should be thoroughly chiseled, and after roughening, use compressed air to blow and

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clean any debris inside the reserved holes.

4.5. High-Precision Embedded Part Installation

For longer high-precision embedded parts that cannot be fabricated in one piece and where installation deviations are difficult to control, a method of block fabrication and on-site assembly should be used for installation. During installation, according to the positioning control lines, install the high-precision embedded parts on the previously welded horizontal rebars, and use wedge shims for elevation adjustment. Each end of each block or segment of T-shaped high-precision embedded parts should have a wedge shim on each side, and an additional set of wedge shims should be added for every additional meter in length over one meter. After adjustment or positioning, steel rebars should be placed on both sides of the reserved holes as bottom support plates, or steel plates can be used locally as bottom support plates. After measuring and leveling, they should be spot welded to the embedded parts (see Figure 2).

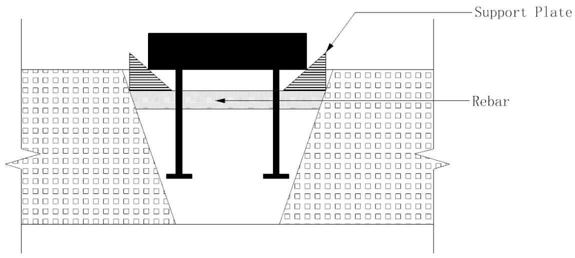

Figure 2: Schematic of Reinforcement for High-Precision Embedded Parts

After installation, measurement rechecks and leveling should be conducted to ensure that the deviation of each group of embedded parts and the deviation of adjacent parallel groups of embedded parts meet the requirements. Anti-floating measures should be taken under the premise of meeting the elevation requirements. Vertical reinforcing bars should be spot welded between the groups of embedded parts and the main rebars of the floor slab and welded firmly to the top horizontal rebars. For a group of parallel embedded parts, the distance deviation of the relative central axes between each group of two, three, four embedded parts and the height difference of the middle embedded parts relative to the top connecting line of the outer two embedded parts should meet the requirements (see Figure 3).

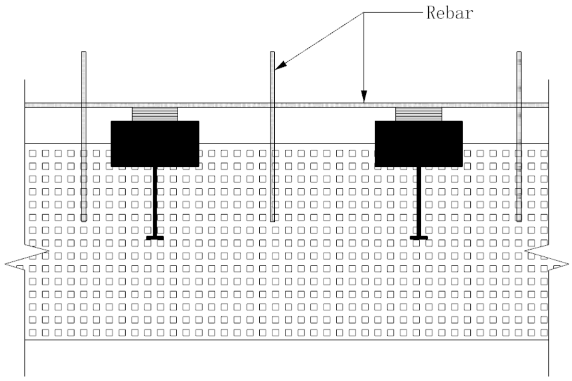

Figure 3: Schematic of Anti-Float Reinforcement for High-Precision Embedded Parts

4.6. Fine-Aggregate Concrete Pouring

After the installation of T-shaped high-precision embedded parts is completed and the measurements meet the requirements, clean the base surface of the reserved holes and moisten it with water. Use fine-aggregate concrete to pour the reserved holes, preventing the hopper or trolley from touching the reinforced T-shaped high-precision embedded parts during pouring. The fine-aggregate concrete should be poured from one side of the embedded parts and compacted with short lengths of threaded rebar or a vibrating rod. If self-compacting concrete is used for pouring, vibration is not necessary, but local compaction can be performed. Do not touch the high-precision embedded parts during the pouring process; if they are accidentally touched, immediately notify the surveying personnel for rechecking. Since there are many holes under the embedded parts, construction personnel should pour and vibrate in multiple groups, strictly avoiding contact with the T-shaped high-precision embedded parts or their

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anchor bars to prevent displacement. During the pouring process, surveying personnel should continuously recheck the elevation and position of the embedded parts and make timely corrections and reinforcements if displacement is found. After pouring is completed, re-measure the elevation and position and issue an internal measurement report (see Figure 4).

Figure 4: Fine-Aggregate Concrete Pouring for T-shaped High-Precision Embedded Parts

4.7. Curing

After the concrete pouring is completed, appropriate curing work should be carried out to achieve the designed strength. At the same time, regular inspections and maintenance of the installed embedded parts should be conducted to ensure their stability and precision throughout their use.

5. Conclusion

Through in-depth research and practical application, this paper has successfully explored an installation process for T-shaped high-precision embedded parts suitable for nuclear power engineering. This process, with careful construction planning and strict technical requirements, ensures the high precision and stability of the embedded parts during installation. Practical results demonstrate that this process significantly enhances the installation quality of embedded parts, meeting the stringent requirements for equipment stability and safety in nuclear power engineering. This not only brings significant economic and social benefits to the construction field of nuclear power engineering but also provides valuable experience and technical references for similar high-precision embedded part installation projects. In the future, we will continue to research and optimize this process, aiming to expand its application in a broader range of fields, contributing more wisdom and strength to the continuous development and progress of the construction industry.

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